

## **Promoting Late-Fall Establishment of Tall Fescue with Soil Covers**

Antonio J. Palazzo, Ronald N. Bailey and Carl Diener

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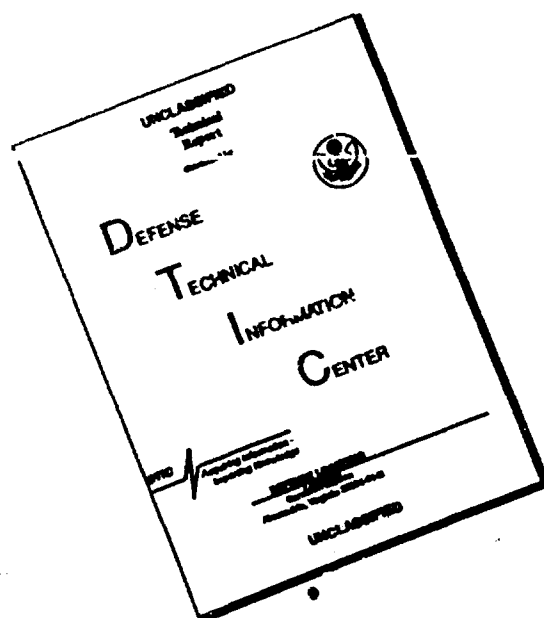
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### **Abstract**

Turfgrass seedlings frequently have been sown in the late fall, which usually results in a poor vegetative stand the following spring. This study evaluated the effects of a spun-bonded polypropylene soil cover placed over a late-fall seeding on subsequent seedling growth and overwintering. Clemfine, Mustang, Rebel and Rebel II cultivars of tall fescue (*Festuca arundinacea* Schreb.) were sown on a silt loam soil in late fall (on 17 October in 1989 and 19 October in 1990) and allowed to grow with and without a soil cover until June. From mid-April through May the temperature under the soil cover was more than 2 °C higher than the uncovered soil. Over the winter, leaf and root weights showed no detrimental effects from being under the cover. All cultivars had similar amounts of growth under the cover and produced 2 to 11 times greater leaf yields and 38 to 270% better stand establishment than those sown on the exposed soil. However, plant winter injury was observed under the soil cover in small soil depressions, which accumulated water originating from thawing. The covers also promoted weed growth, which was negatively correlated to the yields of the sown grass. Plant carbohydrate levels were lower beneath the soil cover than in the control, but the reduction was not sufficient to reduce spring growth. The soil cover was found to be beneficial to the establishment of late seedings of tall fescue in cold areas.

For conversion of SI metric units to U.S./British customary units of measurement consult ASTM Standard E380-89a, *Standard Practice for Use of the International System of Units*, published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.



**U.S. Army Corps  
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Cold Regions Research &  
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## PREFACE

This report was prepared by Antonio J. Palazzo, Research Agronomist; Ronald N. Bailey, Biologist, both of the Geochemical Sciences Branch, Research Division; and Carl Diener, Civil Engineering Technician, Civil and Geotechnical Engineering Research Branch, Experimental Division, U.S. Army Cold Regions Research and Engineering Laboratory. Funding was provided under DA Project 4A762784AT42, *Cold Regions Engineering Technology; Work Unit BS/020, Maintenance of Surfaced and Unsurfaced Areas in Cold Regions*. The authors thank Dr. Gurdarshan Brar, David Cate, R.W. Duell, Dr. Giles Marion and A. Page for review and Arlene Phillips for typing the original manuscript.

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# Promoting Late-Fall Establishment of Tall Fescue with Soil Covers

ANTONIO J. PALAZZO, RONALD N. BAILEY AND CARL DIENER

## INTRODUCTION

Cool-season grasses are sown in the northern U.S. because they are able to provide a rapid and cost-effective plant cover. The best times to sow cool-season grasses are in the spring or fall. Unfortunately many seedings are performed in late fall, which may lead to a poor stand of turfgrass the following spring due to poor emergence of the sown seed, slow seedling development and subsequent winterkill of young seedlings. Poor turf stands can lead directly to an increase in soil erosion and siltation of streams and wetlands.

Slitted plastic and spun-bonded fabric soil covers have been successful in promoting the germination, emergence and seedling growth of vegetable crops sown in the spring. Wells and Loy (1985) concluded that this occurred by increasing air temperatures below the cover during the day. Soil covers have also been shown to lengthen the growing season for some vegetable crops (Wells and Loy 1985) and grasses (Palazzo 1989, Racine et al. 1990). In preliminary studies Palazzo (1989) and Racine et al. (1990) observed increased emergence and better establishment of tall fescue (*Festuca arundinacea* Schreb.) sown in the late fall under a soil cover rather than on bare soil.

Using soil covers in the late fall on newly seeded turfgrasses could have deleterious effects. Since the mean temperature near the plant is elevated, it could be argued that the plant may go through the winter in a more cold-susceptible condition. It is generally believed that plants need to harden off and build up carbohydrate reserves to survive the winter dormant period. Soluble carbohydrates increase in plants during the hardening process in the fall when temperatures are below optimum for photosynthesis and growth (Okajima and Smith 1964, Balasko and Smith 1971, Youngner and

Nudge 1976, Youngner et al. 1978). Soil covers could raise temperatures sufficiently for plant growth to continue into the fall and prevent carbohydrate accumulation or reduce the amount that is stored (Youngner and Nudge 1976). This lack of buildup of plant carbohydrates during the period of hardening may be detrimental to the survival of a late-fall seeding under these soil covers. Also, daytime temperatures beneath the soil cover in the spring will fluctuate more widely than on a bare soil surface. Thomas and Lazenby (1968) found that survival of three tall fescue populations was not as great when the daytime temperature fluctuated widely as when there was continuous low temperature for two weeks after a cold stress.

The objective of this study was to evaluate the use of a spun-bonded polypropylene soil cover for improving seedling establishment of cool-season grasses sown in the late fall. Tall fescue was selected since it is reported to be one of the cool-season grasses that is susceptible to cold injury (Cook and Duff 1976).

## MATERIALS AND METHODS

Seeds of Clemfine, Mustang, Rebel and Rebel II tall fescue (*Festuca arundinacea* Schreb.) were sown on 17 October 1988 and 19 October 1989 on a Hartland silt loam soil (a coarse-silty, mixed, mesic Dystric Eutrochrept), which overlies a well-drained gravel soil in Hanover, New Hampshire. All grasses were seeded at a rate of 22 g m<sup>-2</sup> in 2-m<sup>2</sup> plots. The randomized split-plot experimental design included four replications of each of the four cultivars (Fig. 1). Prior to seeding, the soils were fertilized at a rate of 5 g m<sup>-2</sup> of each of nitrogen, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. After seeding, the plots were rolled, and half of each plot was covered with a spun-bonded

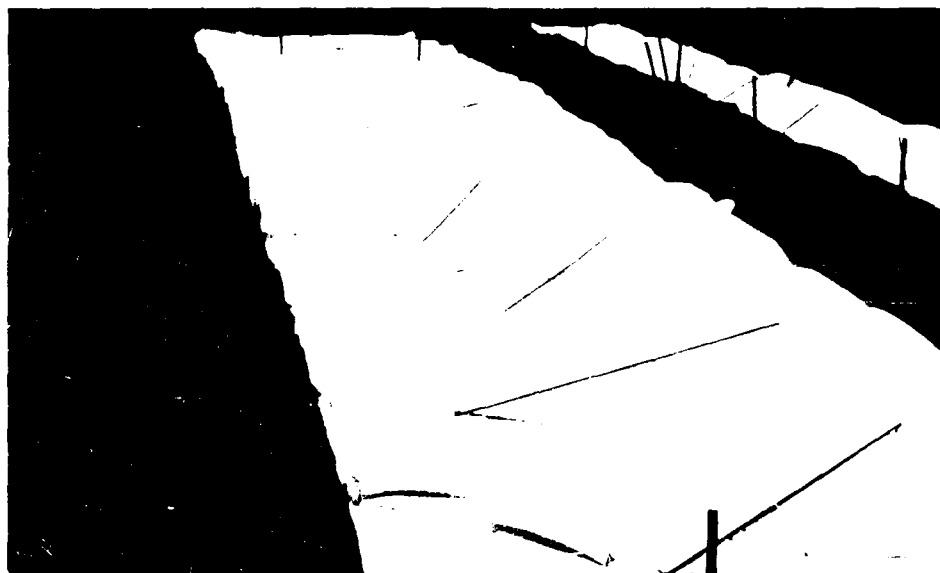


Figure 1. Overview of the research site.

polypropylene material called Tyvar, which is pure white, weighs  $64.4 \text{ g m}^{-2}$  ( $1.9 \text{ oz yd}^{-2}$ ) and provides 60% shade. The cover was secured with long wire staples and rebar as recommended by the manufacturer. (This product is manufactured by the Reemay Company, P.O. Box 511, Old Hickory, Tennessee 37138.)

Soil temperatures were measured at the soil surface at two locations on the plots. Copper-constantan thermocouples attached to nonshielding cable were used; the system used was similar to that described by Culik et al. (1982). Spring soil temperatures were measured hourly in 1989, and the means of six-hour periods were recorded in 1990 with an Omnidata temperature recorder. Soil temperature measurements began when the soil was no longer snow covered. Temperatures were recorded from 15 March to 15 June 1989 and from 15 March to 1 May 1990. The monitoring time was shorter in 1990 due to recording equipment problems. A paired *t*-test was used to determine differences in soil temperature between the covered and uncovered plots from mid-April through May.

General observations of the turf stand were made on 16 November in 1989 and 1990. Plant stand counts were made on 11 April 1989 and 1 May 1990 by counting the number of seedlings in a  $0.33\text{-m}^2$  area. Leaf and root yields were recorded on 19 June 1989 and 12 June 1990, immediately after the cover was removed. Leaf tissue was measured by clipping plants 5 cm above the soil sur-

face in a  $1\text{-m}^2$  area. Immediately after harvesting, a portion of the harvested sown tissue was dried at  $100^\circ\text{C}$  for one hour and at  $70^\circ\text{C}$  for 48 hours to constant weight. Subsamples of the dried tall fescue tissue (each weighing 20 mg) were collected, ground to pass a 40-mesh screen and prepared for analysis of the carbohydrates glucose, fructose, sucrose and fructans using the methods reported by Westhafer et al. (1982). Duplicate subsamples were analyzed, and the mean was recorded for each analyte. The remaining leaf tissue was separated as to sown and weedy species and dried for 48 hours at  $70^\circ\text{C}$ . Root yields were recorded by digging plant roots to a depth of 15 cm from a  $0.33\text{-m}^2$  area; within the area the leaves were harvested. Roots were washed clean, dried at  $70^\circ\text{C}$  for 48 hours and weighed.

Although there was a split-plot experimental design for this study, the variances for the yield data for the cover and cultivar treatments within each year were not found to be homogenous, and therefore an analysis of variance was not used to determine differences for means of both treatments. A paired *t*-test was used to show differences in yields and plant counts between the covered and uncovered treatments. Differences in yields among cultivars within both cover treatments for each year were determined by obtaining the error mean square and least significant difference (LSD) in means. The carbohydrate results were analyzed by analysis of variance; the factors were cultivars and covers. Data from the two years

**Table 1. Mean daily air temperatures and total precipitation during the study.**

Time and dates	Mean daily air temperature (°C)		Total precipitation (mm)	
	1988-89	1989-90	1988-89	1989-90
Prior to seeding (1 Sept to 15 Oct)	12	12	46	97
Fall (15 Oct to 30 Nov)	4	4	129	236
Spring (1 Mar to 15 June)	7	8	247	366

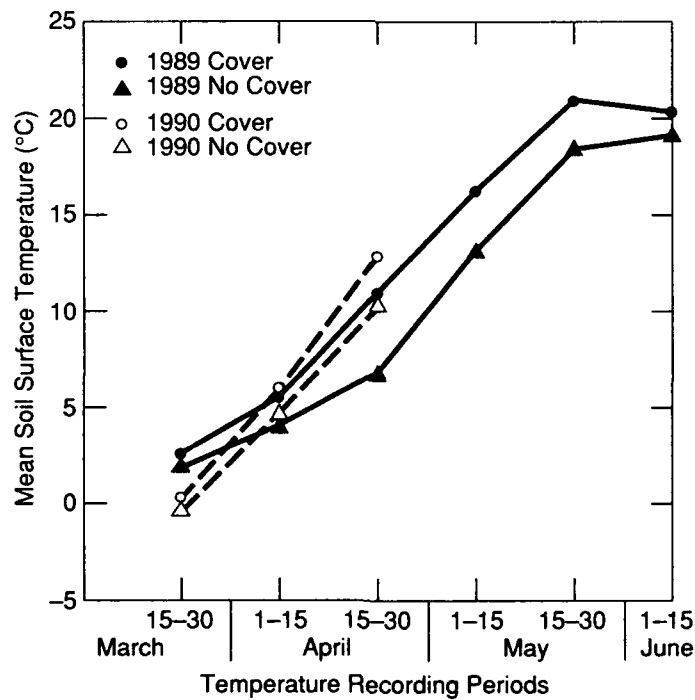
were handled in separate analyses. Whenever a statistically significant *F* value was found in the analysis of variance, means were separated using the LSD test.

## RESULTS

Seeds of four tall fescues cultivars were sown in two successive years in mid-October. Table 1 shows that mean daily temperatures were similar in the

two years, while the site received 68% more precipitation during the second year.

Spring soil temperatures for the bare soil surface and under the soil cover for both years are shown in Figure 2. During both years, mean soil surface temperatures were significantly higher ( $\alpha = 0.01$ ) beneath the cover. The greatest temperature differences (greater than 2°C) occurred during the latter part of April. During the three recording periods from mid-April through May, mean daily soil temperatures beneath the cover

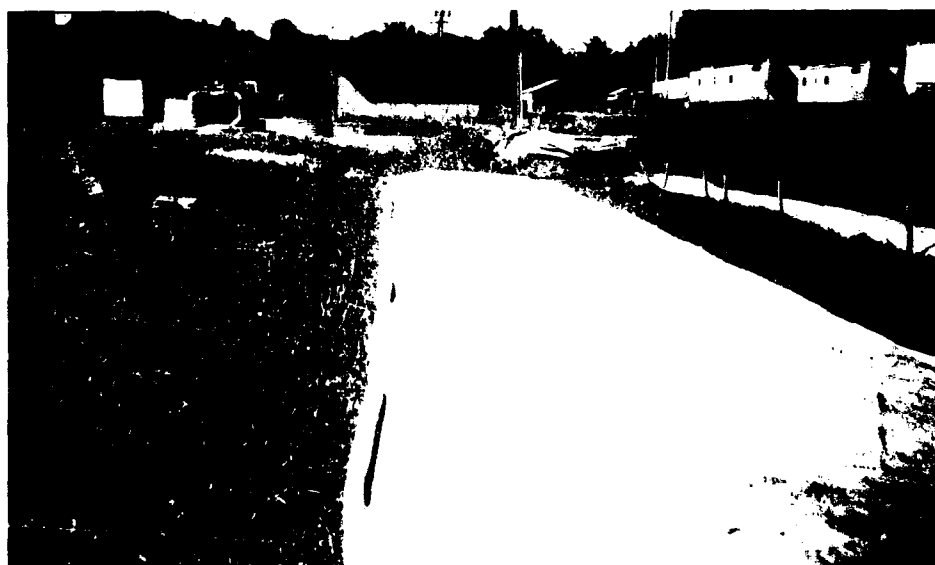


**Figure 2. Bimonthly soil surface temperatures recorded under a soil cover and on bare soil for the two recording periods.**

**Table 2. Plant growth in plots seeded with four tall fescue cultivars.**

Cultivar	Cover	Sown species				Weedy species			
		Leaf yield (g m <sup>-2</sup> )		Plant count (no. m <sup>-2</sup> )		Leaf yield (g m <sup>-2</sup> )		Root yield (g 0.33 m <sup>-2</sup> )	
		1989	1990	1989	1990	1989	1990	1989	1990
Mustang	Yes	41.6a*	26.0a	71a	185ab	15.6a	23.2ab	5.6a	15.5a
Mustang	No	8.8b	6.0bc	—	134b	13.6a	7.6c	4.5a	9.0a
Rebel II	Yes	55.2a	32.0a	100a	182a	14.0a	12.4bc	3.9a	13.1a
Rebel II	No	4.8b	4.4bc	—	121b	18.4a	6.0c	4.3a	7.2a
Clemfine	Yes	50.0a	35.2a	81a	185a	14.8a	18.8bc	4.6a	12.6a
Clemfine	No	15.6b	6.0bc	—	89c	20.0a	6.8c	4.2a	7.4a
Rebel	Yes	16.4b	14.4b	12b	74c	20.0a	32.4a	2.2a	16.1a
Rebel	No	3.2b	1.2c	—	20d	10.4a	5.6c	1.5a	7.2a

\* Means followed by the same letter within each year were not significantly different at the 0.05 level of probability.



*Figure 3. Soil cover prior to removal in June.*



Figure 4. Greater grass growth in the covered plots (right) shown immediately after the cover was removed.

were 3.5, 3.0 and 2.5°C higher than the bare soil. There was a general decline in differences between covered and uncovered soils as ambient temperatures increased. Therefore, the principal benefit in raising soil temperatures by using soil covers was found to be during the early spring before the growing season normally begins.

June leaf yields in 1989 and 1990 of the four tall fescue cultivars sown in mid-October are shown in Table 2. In each year, leaf growth was significantly ( $p \leq 0.05$ ) greater when the grasses were grown under the soil cover (Fig. 3 and 4). Yields for each cultivar under the cover were 2 to 11 times greater for both years than for the uncovered controls. In general, leaf yields were greater in 1989 than in 1990.

Rebel was the lowest-yielding cultivar under the cover each year, while yields of the other cultivars were similar (Table 2). Yields of Rebel under the cover contained 30–55% less biomass than the other cultivars. In the uncovered controls, Rebel was also the lowest yielder, but the means were not statistically different from the other cultivars.

Plant counts were taken on 11 April 1989 and 2 May 1990 to evaluate the effects of the soil cover and cultivar differences on stand establishment

(Table 2). The 11 April 1989 counting date is prior to the beginning of the active spring regrowth period in New Hampshire. Due to slow seed germination in the controls, stand counts were made for only the covered plants. The 2 May 1990 rating date was within the active spring growing season, and stand counts were made in all plots. Stand establishment was consistently better for all of the cultivars growing under a soil cover. Stand counts for each cultivar under the cover ranged from 38 to 270% greater than for the bare soil treatment (Fig. 5). Stand counts for Rebel under the soil cover were lower than for the other cultivars, but the differences were not always significant. From this data it is assumed there was improved emergence after applying the soil cover in the fall and that establishment improvement carried over to the spring.

Total root weights (sown plus weedy species) were taken immediately following leaf harvests each year (data not shown). No significant differences for root weights were found for the soil cover and cultivar treatments. Mean root yields were 12.3 and 10.8 g m<sup>-2</sup> in 1989 and 42.9 and 23.1 g m<sup>-2</sup> for the covered and uncovered treatments, respectively.

Visual observations of the grasses below the



Figure 5. Early fall germination and establishment below the cover (left side of plot).

cover showed that they were more succulent and darker green than those without the cover. Observations made on 16 November 1988 and on the same date in 1989 showed that plants under the cover were taller (30–50 mm taller in 1988) one month after seeding. Observations on 11 April 1988, when plant counts were taken, showed that the soil surface was cracked in the control plots due to frost, while under the cover the soil was settled due to thawing, which is a result of increased warming. Some grass seedlings were killed in a few small patches (<30 mm diameter) where water collected and froze beneath the covers.

Weedy species made up a substantial part of the sward when harvests were made in June of each year (Table 2). The weedy species consisted mostly of winter annual broadleaf species and clover (*Trifolium* sp.). Yields of the weedy species in both covered and uncovered treatments were found to be similar in 1989. In 1990 there were more weeds under the soil cover than on the exposed soils. Weeds made up an average of 34 and 45% of the

total yield in covered and uncovered plots, respectively, in 1989. In 1990, weeds totaled 62 and 65% of the leaf weights harvested from the covered and uncovered plots, respectively. There was a negative linear correlation ( $r = -0.66$ ) between the June yield of the sown grasses and the invasion of weeds.

Total root weights (sown plus weedy species) were measured immediately following harvests each year. No significant differences for root weights were found for the interaction of soil cover and cultivars. In 1990, root yields were greater when the plants were grown under the soil cover. No differences were observed between varieties. Therefore, root yields were promoted by the soil cover.

Four types of carbohydrates were analyzed in the leaves of each cultivar in 1989 and 1990. Carbohydrate contents were usually lower in plants that had the soil cover, with sucrose and fructans contents showing the greatest decline (Table 3). The only exceptions were fructose and glucose concentrations in 1989, which were greater in the covered

**Table 3. Mean carbohydrate contents of four tall fescue cultivars harvested in June.**

Year	Cover	Carbohydrate content (g)				
		Fructose	Glucose	Sucrose	Fructans	Total
1989	Yes	1.73	1.24	2.83	1.65	7.45
	No	0.94	0.68	5.45	4.09	11.16
	LSD <sub>0.05</sub>	0.39	0.35	1.30	0.61	1.82
1990	Yes	2.89	1.74	0.67	0.67	5.97
	No	4.08	2.21	8.18	4.96	19.43
	LSD <sub>0.05</sub>	0.90	0.01	0.85	2.14	1.34

plots. Since yield levels were high, the reduced levels of carbohydrates in June samplings beneath the covers did not appear sufficient to impede plant growth.

## DISCUSSION

The main microclimatic benefit from the use of the polypropylene soil cover was to increase the air temperature at the soil surface. The soil cover promoted stand establishment, increased leaf yields and usually reduced carbohydrate concentrations of four tall fescue cultivars when sampled the following June. Beard (1973) reported that the optimum temperature range for shoot growth of cool-season turfgrasses was between 15.5 and 24.0°C and that growth can occur at temperatures as low as 5.5°C. In this study these optimum temperatures were reached earlier in the spring beneath the cover than on the bare soil. Palazzo (1989) also reported both improved germination rates and taller plants immediately after seeding beneath the same type of soil cover in the fall. Grasses in this study growing below the cover were more succulent and darker green. The lower yields (about 64%) recorded in the 1989-90 growing season compared to the previous year were most likely due to a wetter period after planting that continued into the following spring, since the sown cultivars, planting dates and air temperatures were similar both years. The only winter injury observed beneath the blankets was found in soil pockets, which accumulated water during thawing. The number of injured plants was not great enough to diminish stand and yield advantages gained by using the soil cover.

Yields of Rebel under the cover contained 30–55% less leaf biomass than the other cultivars, but these differences were not usually significant. The reason for the lower yields is not known but could be related to a low germination rate. No direct measurements were taken, but this cultivar did have lower stand counts in early spring and later yields.

The soil covers promoted weed growth, which was found to impede the establishment of the sown species. The growth of the easily controllable weeds (clovers and broadleaves) was promoted under the blanket during one growing season, and they were prevalent during both years. The amount of weeds ranged from 34 to 65% by weight of the total yield. Excessive weed growth below the covers was also cited by Racine et al. (1990).

Soluble plant carbohydrates in these tall fescues were usually lower beneath the covers than in the bare soil controls. The drops in carbohydrate levels, however, were not sufficient to impede growth the following spring and were probably a result of the increased growth rate of the plants. Increased growth rates of plants are known to reduce carbohydrate levels (Waite and Boyd 1953, Okajima and Smith 1964).

In summary, a soil cover was found to be useful for promoting tall fescue seedling growth and numbers (establishment) during late-fall seedings in uniform seedbeds. Although the cost of materials and labor would be higher than in normal seeding operations, the improved plant establishment and increased growth beneath the cover could mean the difference between success and failure in critical cold soil situations and hence could be justified.

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